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Mangroves to aquaculture

Aquaculture Department, Southeast Asian Fisheries Development Center

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Economics

Mangroves to aquaculture

For the Asia Pacific countries, the major objectives for mangrove development are increasing resource production, conserving/sustaining resource production, equity in benefits and better resource management.

Aquaculture then can increase resource production and enhance the equity in benefits from the resource. The yield of shells is 979 kg/ha/yr and that of sea cucumber is 297 kg/ha/yr. Catches for shrimps and fishes are generally no more than 1,000 kg/ha/yr. But using high intensity aquaculture methods, production in kg/ha/yr of the following are attainable in mangrove areas: crustaceans, 10,000; fishes, 10,000; and oysters, 5,000.

Recommendations of strategies regarding the further conversion of mangrove forests to fishponds and the management of existing fishponds for the culture of various aquatic species will be based on the results of the economic analysis.

ECONOMIC FEASIBILITY ANALYSIS

Methods of evalution

Approaches have been proposed for alternative strategies for allocation of mangrove areas for competing uses. A prerequisite for this consideration is the economic feasibility of an alternate strategy. Aquaculture projects in mangrove swamps are evaluated for their economic feasibility using three parameters:

1. **Internal rate of return** (IRR). The IRR for an aquaculture investment project is the discount rate that equates the total present value of the expected cash outflow with the total present value of the expected inflow. In symbols, the IRR is computed as follows:

$$\sum_{t=1}^{n}\left[\frac{A_t}{(1+r)^t}\right]=0$$

$$C_o=\frac{A_1}{(1+r)^1}+\frac{A_2}{(1+r)^2}+\ldots+\frac{A_n}{(1+r)^n}+\frac{S_n}{(1+r)^n}$$

where: C_o = initial cost of acquiring, developing and operating the project at year 0;

A_t = net cash flows at year t;

S_n = salvage value at the end of the project;

n = economic life of the project,

r = internal rate of return of the project.

The acceptance criterion is based on a comparison of IRR with a required rate of return (RRR), which generally is the cost of capital. The project is feasible if the IRR is greater than the RRR; otherwise, it is not a feasible project.

2. **Net present value** (NPV). The NPV method discounts all the net cash flows of the project to present value using the required rate of return. The NPV of an aquaculture investment proposal is given by the formula.

$$NPV=\sum_{t=1}^{n}\left[\frac{At}{(1+r)^t}\right]$$

$$\frac{A_1}{(1+k)^1}+\frac{A_2}{(1+k)^2}+\ldots+\frac{A_n}{(1+k)^n}+$$

$$+\frac{S_n}{(1+k)^n}-C$$

where k = required rate of return.

C = cost

The proposed project is economically feasible if the NPV is greater than zero.

3. **Benefit-Cost Ratio** (B/C). The B/C ratio is the ratio between the total present value of benefits to the total present value of costs. Projects with B/C values greater than one are considered feasible. The B/C ratio is computed as follows:

$$B/C=\frac{\sum_{t=1}^{n}\left[\frac{B_t}{(1+k)^t}\right]}{\sum_{t=1}^{n}\left[\frac{C_t}{(1+k)^t}\right]}$$

where B_t = gross annual revenues (including salvage value) at year t;

C_t = annual operating cost (including initial cost) at year t.

Quantitative assumptions

In the estimation of the annual cash flow of each aquaculture project, the following assumptions were made:

1. ***Total Revenue*** **(TR)**

TR = quantity of each species produced annually x price of each species.

2. ***Capital Expenditure*** **(CE)**

CE = cost of acquiring and developing the farm + cost of equipment: milkfish and shrimp extensive (P100,000/ha), shrimp,semi-intensive (P400,000/ha), and intensive (P500,000/ha).

3. ***Total Operating Cost*** **(TOC)**

TOC = cost of fry + fertilizer + pesticide +feed + labor + electricity + fuel) + interest expenses + income taxes.

4. ***Net Profit After TAxes*** **(NPAT)**

NPAT = total revenue - total operating cost.

5. ***Depreciation*** **(DEPN)**

DEPN = 20% of the values of gates and/or equipment.

6. ***Income Taxes*** **(IT)**

IT = 25% of net profit before taxes below P100,000, otherwise, 35%.

7. ***Interest Expenses*** **(INTE)**

INTE = 25% of loan payable.

Feasibility of developing mangrove areas for various aquaculture Projects

Milkfish and shrimp are the most widely cultured species in brackishwater ponds in the Philippines. Thus, the evaluation of the feasibility of aquaculture projects in mangrove forests are based on the culture of these species at different levels of management, namely:

Milkfish	(1) extensive	(MNR-ADB, 1983, Code: Pangasinan-13)
	(2) improved	(MNR-ADB, 1983,Code: Iloilo-18)
	(3) extensive with feeding	
	(4) improved method with feeding	
Polyculture	(5) milkfish-shrimp	(MNR- ADB, 1983, Code: Aklan-3)
Integration	(6) Milkfish-salt (Pudadera, 1986)	
Shrimp	(7) extensive	(MNR-ADB, 1983, Code: Capiz-10)
	(8) semi-intensive	
	(9) intensive	(Camacho and Corre, 1986)

Note: Modifications were made in the case studies to provide values of current prices for the cost and benefit.

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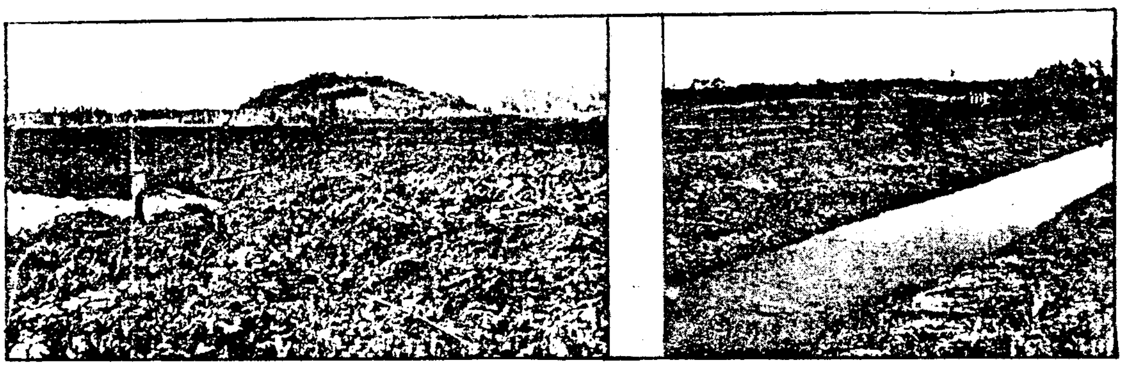

Despite strongly acid sulphate soil conditions, well-developed mangrove forests in the Merbok estuary of Western Peninsular Malaysia were cleared for aquaculture in 1981.

Milkfish. With the present market structure of the milkfish industry, both the extensive and the improved method of milkfish farming were found to be not feasible projects. This is indicated by the low IRR (0.0 percent and 2.1 percent, respectively), the negative NPV and the B/C ratio of less than one (0.48 and 0.66, respectively). The IRR of both projects are far below the required rate of return of 25 percent.

Increasing the production twofold by doubling the stocking density and providing for supplementary feeding tended to improve the profitability of both systems, but the projects were still not feasible. The improvement was bigger in the case of the improved method with feeding. The higher IRR of 4.78 percent suggests that this project would become feasible if the cost of capital is 4.78 percent. The B/C ratio of 0.82 suggests that if cost decreases or revenue increases the project could become feasible.

Polyculture. The polyculture of milkfish and shrimp in an extensive system which yielded 0.8 mt of milkfish/ha/yr and 0.07 t of shrimp/ha/yr in a 1.5 ha farm was shown to be economically unacceptable. The total discounted benefits could cover only half of the total discounted costs.

"Research on the prevention and control of shrimp diseases and pond wastes must be undertaken, including studies on the nutritional requirements and feeding behavior of shrimp to improve feeding strategies and formulate cost-efficient pellets."

Integration. It was assumed that a 9 ha pond developed for milkfish-salt production would require an initial cost of P1.8 million. This farm yielded 1.6 t of milkfish/ha/yr and 25 t of salt/ha/yr. This alternative proved to be more profitable than the monoculture or polyculture of milkfish. The present market structure of milkfish and salt, however, made the project not feasible unless the cost of capital would decrease to 5.54 percent. The present structure resulted in discounted earnings covering three-fourths of the discounted costs.

Shrimps. The economic analysis showed that the use of mangrove resources for the extensive culture of shrimps, yielding 0.11 t/ha/yr is not feasible. The semi-intensive and intensive culture methods, yielding 5.0 t/ha/yr and 10.0 t/ha/yr, respectively, are, however, economically feasible. The discounted income would recover only 55 percent of the discounted costs for extensive culture. By contrast, the discounted income of semi-intensive and intensive systems was higher than the discounted costs by at least 12 percent. Consistently, the NPV was positive for the latter two systems and IRR (34.3 percent and 39.8 percent, respectively) higher than the cost of capital. The semi-intensive and intensive methods of culturing shrimps therefore, were promising alternative uses for mangrove areas.

Sensitivity analysis

To determine the effects of a change in revenue or cost item on the viability of an alternative aquaculture use of mangrove areas, sensitivity analysis of IRR was employed. Three types of projects which were feasible or showed promise of becoming feasible, were subjected to this analysis.

Milkfish. The economic feasibility analysis showed that milkfish culture, using the improved method with feeding was not economically feasible. The sensitivity analysis showed that this culture method could become viable if capital expenditures fall by 50 percent and the cost of borrowing is

20 percent. A rise in the selling price of milkfish by 50 percent could generate an IRR of 18 percent, which was still below the required rate. A reduction in the cost of fry or feed by as much as 50 percent could not drastically increase the IRR and the project remained not viable.

FLASH! FLASH! FLASH! FLASH!

Eliseo Capistrano, Sr. had a bumper harvest and brisk sale of bangus weeks after the mega-typhoon Rosing devastated most of the fishponds in Pagbilao, Quezon. The reason? His fishponds were protected by mangroves! Aside from making the dikes massive, Mr. Capistrano maintains and protects the thick growth of mangroves that separated his fishpond from the China Sea. The dikes of most fishponds within the area were destroyed by the big waves during the typhoon.

*Source: **The Manila Bulletin**, Jan. 5, 1996*

Shrimp. The economic feasibility analysis showed that both intensive and semi-intensive culture of shrimp were the most profitable of the aquaculture projects evaluated. These were the only projects found to be feasible under the present market structure. The sensitivity analysis of the IRR, however, showed that both projects could remain viable if the market price of shrimp does not fall by less than 15 percent. The intensive culture of shrimp was more sensitive to a price drop, but the IRR increased at a faster rate as the market price improved. The semi-intensive culture of shrimp remained viable up to about 30 percent increase in the cost of capital while that of intensive culture could take an increase of as much as 50 percent. Because of the use of fewer fry and lower quality feed which was cheaper, the semi-intensive culture was less sensitive to fluctuations of feed and fry cost. In the intensive culture, large increase of IRR were observed with the decrease in feed and fry cost while an increase in the feed cost beyond 30 percent could make the project not feasible.

Implications of the Economic Feasibility and Sensitivity Analysis

Milkfish comprised over 90 percent of the fish produced in fishponds. Today, with the high cost of pond development and the price structure of milkfish, none of the methods of culturing milkfish, was found to be economically feasible. The only milkfish project which exhibited an economic potential was the improved management technique with supplementary feeding so that higher stocking densities could be sustained. Unfortunately, this is a technology that is still to be developed. Milkfish as one of the most widely eaten fish in the Philippines can greatly influence the prices of the fishes thus, government intervention to increase milkfish production is needed. The analysis showed that this can be done not by expanding the area of brackishwater ponds. A program that can increase the profitability of milkfish farming to make the project feasible includes financing research programs aimed at developing a more intensive and profitable technology, providing lower interest loans and decreasing taxes imposed on profits. Moreover, without providing for a salvage value for the developed ponds, none of the aquaculture projects would be viable on the basis of a feasibility analysis. This suggests that the government needs to compensate for the cost of development of a mangrove leased in case the lease contract is not renewed. Without such programs farmers will continue to lose interest in milkfish culture and would shift to the culture of shrimps and other luxury species.

The economic analysis showed that only semi-intensive and intensive culture of shrimp was profitable. Both these culture techniques do not require vast areas of ponds. Furthermore, for

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not require vast areas of ponds. Furthermore, for certain technical consideration, intensive shrimp ponds are often not built in mangrove areas but are instead built in higher elevation fertile lands beside the sea. This suggests that shrimp production to increase the dollar earning capacity of the country, can increase without having an adverse effect on fish production. It is interesting to note that the attractive price of shrimp today is a factor responsible for the high profitability of intensive culture, even as it requires the highest production cost per kg of shrimp and lower capital costs. Its profitability is less prone to changes in shrimp prices, and the shrimp stock is less prone to the outbreak of diseases. Thus, it is an aquaculture project recommended in certain suitable mangrove areas.

Strategy for the management of Philippine mangrove

The economic feasibility analysis as presented, did not consider trade-offs such as those due to environmental degradation, losses to wildlife, the impact on human health, or social equity distribution of costs and benefits. But in order to consider these, certain quantitative or monetary values need to be assigned to the various alternative uses of mangroves. This has met many difficulties, such as those that follow:

1. The willingness of the population to pay for the trade-off for a competing activity such as a life-support system would be difficult to measure because of certain limitations. The amount of disposable income, government policy and the education of the people are among the factors that may cause one to prefer something which is not necessarily promoting his health or well-being.

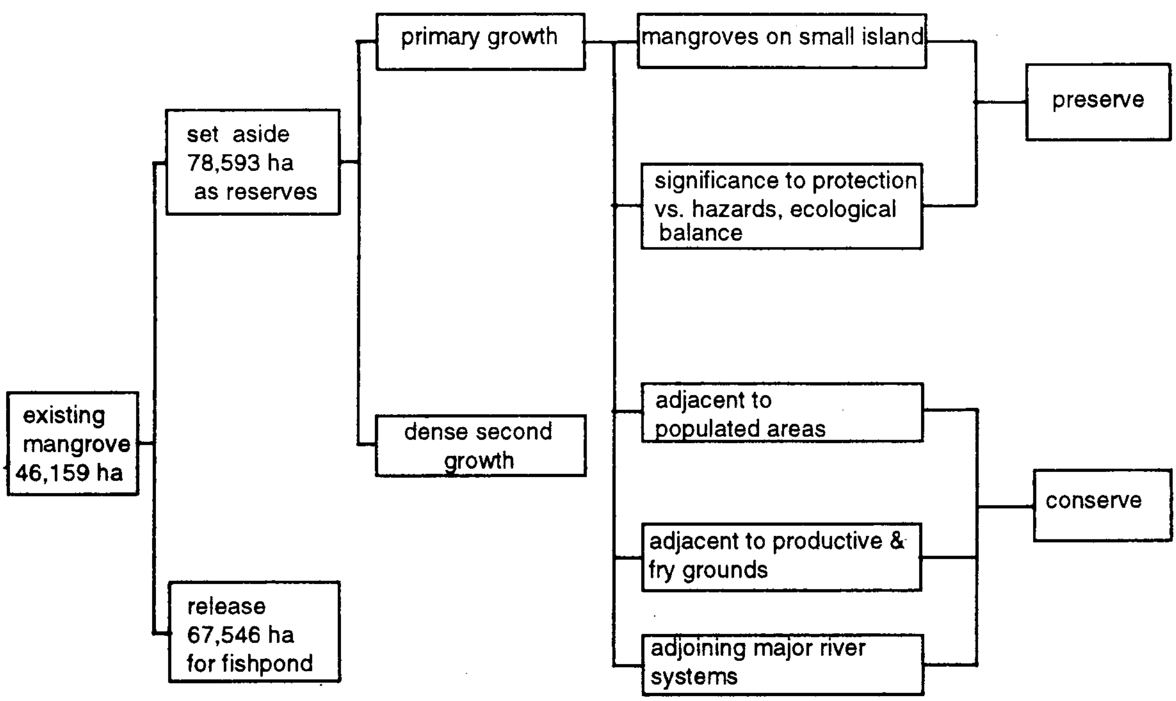
2. It is difficult to quantify the extent of the trade-off of one activity resulting from another activity. For example, the loss of a fishery due to fishpond development cannot be proven, nor can the contribution of fishpond development to the decrease in fishery be quantified.

3. The value of mangrove for various competing uses is site-specific. For example, its value for pollution control or for residential use is higher in population centers than in less populated areas. Thus, the tremendous advantage of preservation demonstrated by some is actually site dependent.

If more mangrove areas are to be allocated for fishpond development, then, one alternative action that can be used for the site selection is the one proposed by P. Zamora in 1981 as shown below.

During the last few years, with the permis-

Guidelines for the selection of mangrove areas for preservation, conservaiton and fishpond development



age system, vast areas of the remaining mangrove forests have been destroyed for conversion to fishponds. Many of these areas had very low production or were eventually confiscated by banks because of inability to keep up with loan payments. This is a sign of either mismanagement of the loans or of the lack of economic feasibility. Results of the economic feasibility analysis showed that in the recent years, the latter is likely to happen. Concern over the low profitability and low yields of milkfish farming have been demonstrated recently. This can be attributed to the reduced per capita fish consumption resulting from declining real wages and inflation, as the cost of inputs increases.

The only way for aquaculture ventures to become feasible and more profitable is to go intensive. Thus, for both economic and ecological purposes, it is concluded that no additional mangrove forests should be allocated for fishpond development. Strict enforcement to restrict further conversion of mangrove forests to fishponds should be practiced. For purposes of equity in benefits of areas already allocated for fishpond development, the lease contract should be terminated for violators of the agreement and the area redistributed in smaller parcels.

Logging in mangrove forests has become less important since 1971 so that today, it is of little economic value. It is therefore evident that leaving these forests as reserves can provide the population with tremendously higher returns in terms of benefit as wildlife sanctuary, pollution sink, nutrient enrichment, nursery and breeding ground and maintenance of sustained yield of brackishwater fishes and marine fishes, shoreline protection and natural land reclamation, among others. Benefits as such were estimated to be twenty-five fold higher than the direct benefits of paddy cultivation in India. If losses or decreases in these benefits would have entered as indirect costs in an extended benefit-cost analysis, the case against the conversion of mangrove forests to fishponds would have been further strengthened.

Source: Chiu, YN, BC. Posadas and VJ Estilo. ***Strategy for a cost/benefit analysis in the conversion of mangrove areas to aquaculture.*** *UP in the Visayas, Iloilo City.*

'Mangrove forests as reserves can provide the population with tremendously higher returns in terms of benefit as wildlife sanctuary, pollution sink, nutrient enrichment, nursery and breeding ground and maintenance of sustained yield of brackishwater fishes and marine fishes, shoreline protection and natural land reclamation.'